

CLAIMS

What is claimed is:

1. A reactive composition, comprising:
a metal material defining a continuous phase and having an energetic material comprising at least one oxidizer, at least one class 1.1 explosive, or mixtures thereof dispersed therein.
2. The reactive composition of claim 1, wherein the metal material comprises a fusible metal alloy having a melting point ranging from approximately 46°C to approximately 250°C.
3. The reactive composition of claim 2, wherein the fusible metal alloy comprises at least one metal selected from the group consisting of bismuth, lead, tin, cadmium, indium, mercury, antimony, copper, gold, silver, and zinc.
4. The reactive composition of claim 1, wherein the metal material comprises a fusible metal alloy having a melting point ranging from approximately 75°C to approximately 105°C.
5. The reactive composition of claim 1, wherein the metal material has a density greater than approximately 7 g/cm³.
6. The reactive composition of claim 1, wherein the metal material comprises a fusible metal alloy having 50% bismuth, 25% lead, 12.5% tin, and 12.5% cadmium.
7. The reactive composition of claim 1, wherein the metal material comprises a fusible metal alloy having 57% bismuth, 26% indium, and 17% tin.

8. The reactive composition of claim 1, wherein the at least one oxidizer is selected from the group consisting of ammonium perchlorate, potassium perchlorate, sodium nitrate, potassium nitrate, ammonium nitrate, lithium nitrate, rubidium nitrate, cesium nitrate, lithium perchlorate, sodium perchlorate, rubidium perchlorate, cesium perchlorate, magnesium perchlorate, calcium perchlorate, strontium perchlorate, barium perchlorate, barium peroxide, strontium peroxide, copper oxide, sulfur, and mixtures thereof.

9. The reactive composition of claim 1, wherein the at least one class 1.1 explosive is selected from the group consisting of trinitrotoluene, cyclo-1,3,5-trimethylene-2,4,6-trinitramine, cyclotetramethylene tetranitramine, hexanitrohexaazaisowurtzitane, 4,10-dinitro-2,6,8,12-tetraoxa-4,10-diazatetracyclo-[5.5.0.0^{5,9}.0^{3,11}]-dodecane, 1,3,3-trinitroazetidine, ammonium dinitramide, 2,4,6-trinitro-1,3,5-benzenetriamine, dinitrotoluene, and mixtures thereof.

10. The reactive composition of claim 1, wherein the energetic material is in a dispersed particulate phase.

11. The reactive composition of claim 1, further comprising a polymer/plasticizer system.

12. The reactive composition of claim 11, wherein the reactive composition comprises a substantially homogenous mixture of the metal material and the energetic material.

13. The reactive composition of claim 11, wherein the polymer/plasticizer system comprises at least one polymer selected from the group consisting of polyglycidyl nitrate, nitratomethylmethyloxetane, polyglycidyl azide, diethyleneglycol triethyleneglycol nitraminodiacetic acid terpolymer, poly(bis(azidomethyl)oxetane), poly(azidomethylmethyl-oxetane), poly(nitraminomethyl methyloxetane), poly(bis(difluoroaminomethyl)oxetane), poly(difluoroaminomethylmethyloxetane), copolymers thereof, cellulose acetate butyrate, nitrocellulose, nylon, polyester, fluoropolymers, energetic oxetanes, waxes, and mixtures thereof.

14. The reactive composition of claim 11, wherein the polymer/plasticizer system comprises at least one plasticizer selected from the group consisting of bis(2,2-dinitropropyl) acetal/bis(2,2-dinitropropyl)formal, dioctyl sebacate, dimethylphthalate, dioctyladipate, glycidyl azide polymer, diethyleneglycol dinitrate, butanetrioltrinitrate, butyl-2-nitratoethyl-nitramine, trimethyloethanetrinitrate, triethylene glycoldinitrate, nitroglycerine, isodecylperlargonate, dioctylphthalate, dioctylmaleate, dibutylphthalate, di-n-propyl adipate, diethylphthalate, dipropylphthalate, citroflex, diethyl suberate, diethyl sebacate, diethyl pimelate, and mixtures thereof.

15. The reactive composition of claim 1, wherein the reactive composition has a density greater than approximately 2 g/cm³.

16. The reactive composition of claim 1, further comprising a second metal material selected from the group consisting of aluminum, nickel, magnesium, silicon, boron, beryllium, zirconium, hafnium, zinc, tungsten, molybdenum, copper, titanium, sulfur, and mixtures thereof.

17. The reactive composition of claim 16, wherein the second metal material comprises aluminum hydride, magnesium hydride, or a borane compound.

18. The reactive composition of claim 1, wherein the reactive composition comprises a heterogeneous, granulated mixture of the metal material and the energetic material.

19. A method of producing a reactive composition, comprising:
providing a metal material in a liquid state; and
adding an energetic material to the metal material in the liquid state.

20. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a melting point below a processing temperature of the reactive composition.

21. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a melting point from approximately 46°C to approximately 250°C.

22. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a melting point from approximately 75°C to approximately 105°C.

23. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy comprising at least one metal selected from the group consisting of bismuth, lead, tin, cadmium, indium, mercury, antimony, copper, gold, silver, and zinc.

24. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having 50% bismuth, 25% lead, 12.5% tin, and 12.5% cadmium.

25. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having 57% bismuth, 26% indium, and 17% tin.

26. The method of claim 19, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a density greater than approximately 7 g/cm³.

27. The method of claim 19, wherein providing a metal material in a liquid state comprises providing from approximately 40% to approximately 80% of the fusible metal alloy.

28. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises mixing an organic or inorganic energetic material with the metal material.

29. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises mixing a solid or a liquid energetic material with the metal material.

30. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises mixing an energetic material selected from the group consisting of ammonium perchlorate, potassium perchlorate, sodium nitrate, potassium nitrate, ammonium nitrate, lithium nitrate, rubidium nitrate, cesium nitrate, lithium perchlorate, sodium perchlorate, rubidium perchlorate, cesium perchlorate, magnesium perchlorate, calcium perchlorate, strontium perchlorate, barium perchlorate, barium peroxide, strontium peroxide, copper oxide, trinitrotoluene, cyclo-1,3,5-trimethylene-2,4,6-trinitramine, cyclotetramethylene tetranitramine, hexanitrohexaazaisowurtzitane, 4,10-dinitro-2,6,8,12-tetraoxa-4,10-diazatetracyclo-[5.5.0.0^{5,9}.0^{3,11}]-dodecane, 1,3,3-trinitroazetidine, ammonium dinitramide, 2,4,6-trinitro-1,3,5-benzenetriamine, dinitrotoluene, sulfur, and mixtures thereof with the metal material.

31. The method of claim 19, further comprising adding a polymer/plasticizer system to a mixture of the energetic material and the metal material to form a substantially homogenous mixture.

32. The method of claim 31, wherein adding a polymer/plasticizer system to a mixture of the energetic material and the metal material comprises adding at least one polymer selected from the group consisting of polyglycidyl nitrate, nitratomethylmethyloxetane, polyglycidyl azide, diethyleneglycol triethyleneglycol nitraminodiacetic acid terpolymer, poly(bis(azidomethyl)oxetane), poly(azidomethylmethyl-oxetane), poly(nitraminomethyl methyloxetane), poly(bis(difluoroaminomethyl)oxetane), poly(difluoroaminomethylmethyloxetane), copolymers thereof, cellulose acetate butyrate, nitrocellulose, nylon, polyester, fluoropolymers, energetic oxetanes, waxes, and mixtures thereof.

33. The method of claim 31, wherein adding a polymer/plasticizer system to a mixture of the energetic material and the metal material comprises adding at least one plasticizer selected from the group consisting of bis(2,2-dinitropropyl)acetal/bis(2,2-dinitropropyl)formal, dioctyl sebacate, dimethylphthalate, dioctyladipate, glycidyl azide polymer, diethyleneglycol dinitrate, butanetrioltrinitrate, butyl-2-nitratoethyl-nitramine, trimethylolethanetrinitrate, triethylene glycoldinitrate, nitroglycerine, isodecylperlargonate, dioctylphthalate, dioctylmaleate, dibutylphthalate, di-n-propyl adipate, diethylphthalate, dipropylphthalate, citroflex, diethyl suberate, diethyl sebacate, diethyl pimelate, and mixtures thereof.

34. The method of claim 31, further comprising pouring the substantially homogenous mixture into a mold and allowing the substantially homogenous mixture to solidify.

35. The method of claim 19, further comprising adding a second metal material selected from the group consisting of aluminum, nickel, magnesium, silicon, boron, beryllium, zirconium, hafnium, zinc, tungsten, molybdenum, copper, titanium, sulfur, and mixtures thereof to the energetic material and the metal material.

36. The method of claim 35, wherein adding a second metal material comprises adding aluminum hydride, magnesium hydride, or a borane compound to the energetic material and the metal material.

37. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises mixing the metal material and the energetic material to form a reactive composition having a density greater than approximately 2 g/cm^3 .

38. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises adding a solid energetic material to the metal material in the liquid state.

39. The method of claim 38, wherein adding a solid energetic material to the metal material in the liquid state comprises forming a dispersion of the solid energetic material in the metal material.

40. The method of claim 19, wherein adding an energetic material to the metal material in the liquid state comprises adding a liquid energetic material to the metal material in the liquid state.

41. The method of claim 40, wherein adding a liquid energetic material to the metal material in the liquid state comprises forming an emulsion of the solid energetic material in the metal material.

42. A method of improving homogeneity of a reactive composition, comprising:
providing a metal material in a liquid state;
adding an energetic material to the metal material in the liquid state; and
adding a polymer/plasticizer system to a mixture of the energetic material and the metal material.

43. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a melting point ranging from approximately 46°C to approximately 250°C.

44. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a melting point ranging from approximately 75°C to approximately 105°C.

45. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy comprising at least one metal selected from the group consisting of bismuth, lead, tin, cadmium, indium, mercury, antimony, copper, gold, silver, and zinc.

46. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having 50% bismuth, 25% lead, 12.5% tin, and 12.5% cadmium.

47. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having 57% bismuth, 26% indium, and 17% tin.

48. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a fusible metal alloy having a density greater than approximately 7 g/cm³.

49. The method of claim 42, wherein providing a metal material in a liquid state comprises providing a reactive composition having from approximately 13.5% to approximately 85% of the metal material in the liquid state.

50. The method of claim 42, wherein adding an energetic material to the metal material in the liquid state comprises mixing an energetic material selected from the group consisting of ammonium perchlorate, potassium perchlorate, sodium nitrate, potassium nitrate, ammonium nitrate, lithium nitrate, rubidium nitrate, cesium nitrate, lithium perchlorate, sodium perchlorate, rubidium perchlorate, cesium perchlorate, magnesium perchlorate, calcium perchlorate, strontium perchlorate, barium perchlorate, barium peroxide, strontium peroxide, copper oxide, trinitrotoluene, cyclo-1,3,5-trimethylene-2,4,6-trinitramine, cyclotetramethylene tetranitramine, hexanitrohexaazaisowurtzitane, 4,10-dinitro-2,6,8,12-tetraoxa-4,10-diazatetracyclo-[5.5.0.0^{5,9}.0^{3,11}]-dodecane, 1,3,3-trinitroazetidine, ammonium dinitramide, 2,4,6-trinitro-1,3,5-benzenetriamine, dinitrotoluene, sulfur, and mixtures thereof with the metal material.

51. The method of claim 42, wherein adding a polymer/plasticizer system to a mixture of the energetic material and the metal material comprises adding at least one polymer selected from the group consisting of polyglycidyl nitrate, nitratomethylmethyloxetane, polyglycidyl azide, diethyleneglycol triethyleneglycol nitraminodiacetic acid terpolymer, poly(bis(azidomethyl)oxetane), poly(azidomethylmethyl-oxetane), poly(nitraminomethyl methyloxetane), poly(bis(difluoroaminomethyl)oxetane), poly(difluoroaminomethylmethyloxetane), copolymers thereof, cellulose acetate butyrate, nitrocellulose, nylon, polyester, fluoropolymers, energetic oxetanes, waxes, and mixtures thereof.

52. The method of claim 42, wherein adding a polymer/plasticizer system to a mixture of the energetic material and the metal material comprises adding at least one plasticizer selected from the group consisting of bis(2,2-dinitropropyl)acetal/bis(2,2-dinitropropyl)formal, dioctyl sebacate, dimethylphthalate, dioctyladipate, glycidyl azide polymer, diethyleneglycol dinitrate, butanetrioltrinitrate, butyl-2-nitratoethyl-nitramine, trimethylolethanetrinitrate, triethylene glycoldinitrate, nitroglycerine, isodecylperlargonate, dioctylphthalate, dioctylmaleate, dibutylphthalate, di-n-propyl adipate, diethylphthalate, dipropylphthalate, citroflex, diethyl suberate, diethyl sebacate, diethyl pimelate, and mixtures thereof.

53. The method of claim 42, wherein adding a polymer/plasticizer system to a mixture of the energetic material and the metal material comprises adding the polymer/plasticizer system in a range from approximately 0.5% to approximately 50%.